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ABSTRACT

The conversion to the metric system of measurement and resulting advantages over the English system are discussed. Names of metric units are listed along with the multiplication factors indicated by their prefixes. A comparison of the major units of both systems using everyday quantities and sizes is made and a guide for estimating the most common household measurements is included. Several examples concerning area, weight, and volume provide calculations carried out in both systems. (MN)

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WHAT ABOUT METRIC?

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SE 023 476

GOOD NEWS

You use weights and measures every day of your life. Without them, shopping, trade, recreation, and education would be in a state of hopeless confusion.

You learned the language of measurement so early that you have probably forgotten the day you first understood the meaning of "inch, foot, yard, and mile;" of "ounce, pound, and ton;" of "pint, quart, and gallon;" and that "100 °F" is uncomfortably hot, while "30 °F" is uncomfortably cold. These are familiar units of the "customary" system of measurement.

After many years of debate, our nation recently embarked on a voluntary coordinated change from the customary system of measurement (the yard and pound) to the metric system of measurement (the meter and kilogram). On December 23, 1975, President Ford signed into law the Metric Conversion Act of 1975, which established for the first time a national policy to coordinate America's changeover to metric. Thus, the United States joined the worldwide trend toward a comparatively new system called the "modernized metric system" of measurement.

The names of the units in the metric system may sound strange to the American ear at first, but fortunately there are only a few words that have to be learned for everyday use. These are: the *kilometer, meter, centimeter* and *millimeter* for expressing length and distance; the *liter* and *milliliter* for capacity or volume; the *kilogram, gram* and *metric ton* for weight (mass); the *degree Celsius* for temperature; the *kilopascal* for pressure; and the *hectare* for area.

As we convert to the metric system, several units of measure that we currently use will not change. Time will continue to be measured in hours, minutes, and seconds; electric power will still be measured in watts; and our monetary system will remain the same.

The metric system is already being used in this country to a greater extent than most people realize. In international athletic competition, such as swimming and track and field events, length measurements are given in *meters* rather than in yards and feet. Our astronauts, from

the surface of the moon, excitedly told a worldwide audience how far their rocket had landed from a lunar hill in *meters*. You see weights expressed in *grams* on more and more packaged items at the grocery store. And the trend is toward even greater use.

0 0 0 7 8 7

Why is the metric system being INCREASINGLY USED?

The metric system is increasingly in use throughout the world for two reasons: it is a *simple* system, and it is a *decimal* system.

It is simple because each quantity, such as length (meter) or weight (gram), has its own unit of measurement, and no unit is used to express more than one quantity. In the customary system, however, pound can mean either force (as in pounds required to break a rope) or weight (as in a pound of sugar); and ounce can mean either volume (as the number of ounces in a quart) or weight (as the number of ounces in a pound).

The metric system is easier than the customary system to learn to use in solving problems that involve computation. This is because multiples of metric units are related to each other by the factor 10. You have probably noticed that the names of metric units sometimes include prefixes such as milli, centi, and kilo as in milliliter, centimeter, and kilogram. These prefixes indicate multiples or submultiples of the units.

Consider the measurement of length—in the metric system any measure of length is expressed in meters or multiples of the meter. A *centi*meter is one hundredth of a meter; a *milli*meter is one thousandth of a meter; and a *kilo*meter is one thousand meters. In the customary system, an inch is one thirty-sixth of a yard; a foot is one third of a yard; and a mile is 1760 yards.

The most commonly-used prefixes, and the multiplication factors they indicate, are given on the following pages.

1 WEIGHT

1 kilogram =
1 hectogram =
1 dekagram =
1 gram
1 decigram =
1 centigram =
1 milligram =

2 LENGTH

1 kilometer
1 hectometer
1 dekameter
1 meter
1 decimeter
1 centimeter =
1 millimeter

*units not commonly used

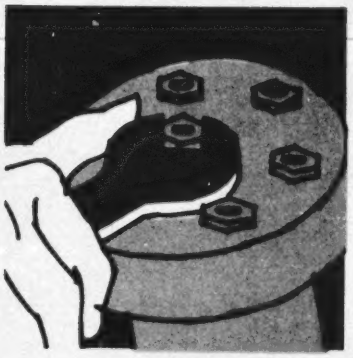
3

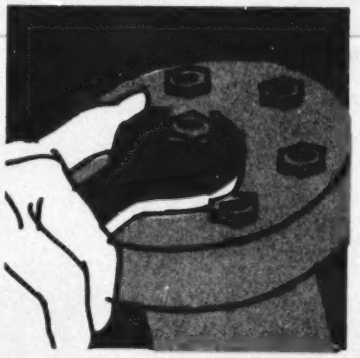
liter
liter
liter
liter
liter
liter

4

A visual comparison of metric and customary units of measurement

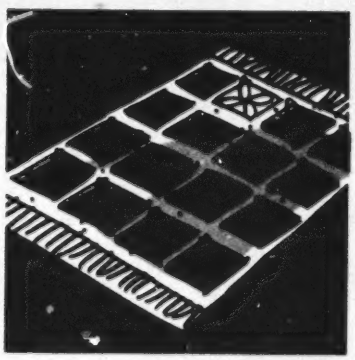
In the examples below, a visual comparison is made of the major units of the customary and metric systems, by using everyday quantities and sizes for purposes of illustration.

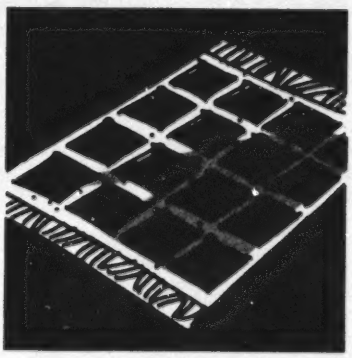




Small linear dimensions

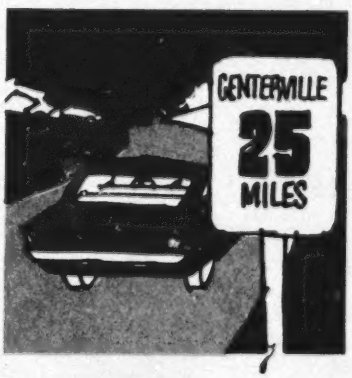
For expressing small linear dimensions, such as wrench sizes, millimeters will replace inches. For example, a 6-mm wrench will be a more commonly-used size than a ¼-inch wrench





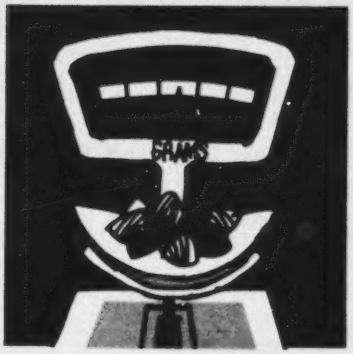
Larger linear dimensions

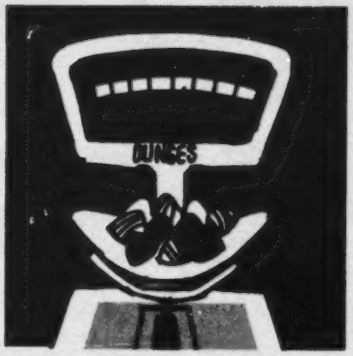
In expressing larger sizes, the meter will replace both the foot and the yard. In the example shown, a 3 × 4 meter carpet will generally be sold rather than a 9 × 12 foot (or 3 × 4 yard) carpet.



Great Distances

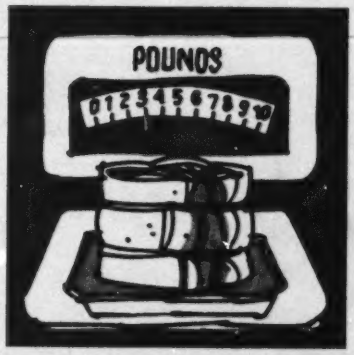
The kilometer will replace the mile in expressing great distances, such as distances between cities. The example shows the replacement for a sign 25 miles from Centerville: it would read 40 kilometers.





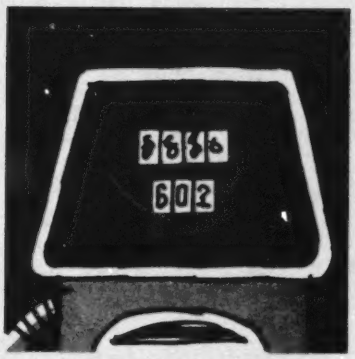
Small Weights

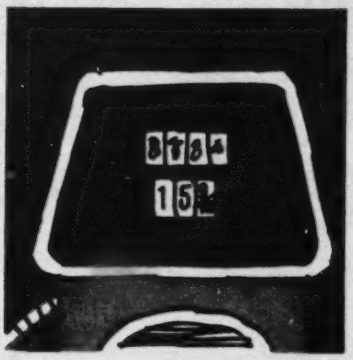
When we purchase small quantities of things, such as candy, we will use grams instead of ounces. For example, 250 grams will replace 9 ounces.



Larger Weights

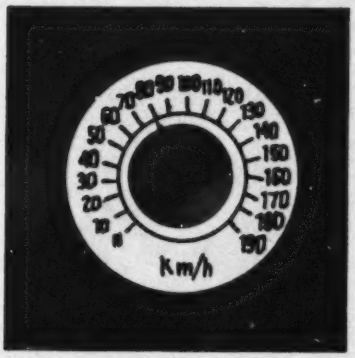
The purchase of large items, such as meat, will be figured in kilograms rather than pounds. In the example shown, a 2-kilogram roast will replace a 4.5-pound roast.

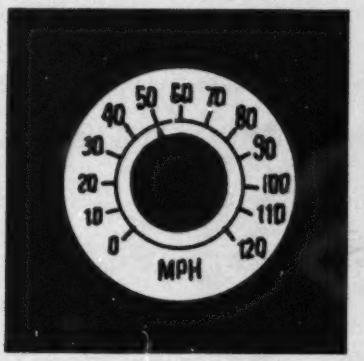




Volume

When you order a tankful of gas, you may note that it will take 60 liters rather than 16 gallons.





Speed

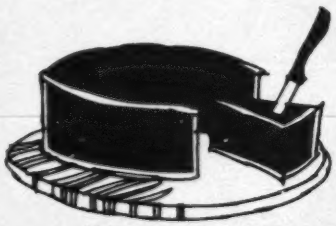
Our automobile speedometers will change from miles per hour to kilometers per hour as the speed limit signs on our highways are likewise changed. On the speedometers shown, an 80 kilometers per hour speed replaces 50 miles per hour.

METRICour

a handy guide for estimating the most common household measurements

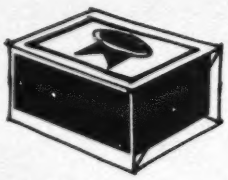
1 WEIGHT

1 kilogram = 2.2 pounds



250 grams = 8.8 ounces

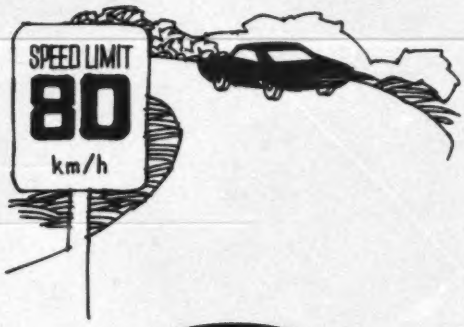
500 grams
= 1.1 pounds

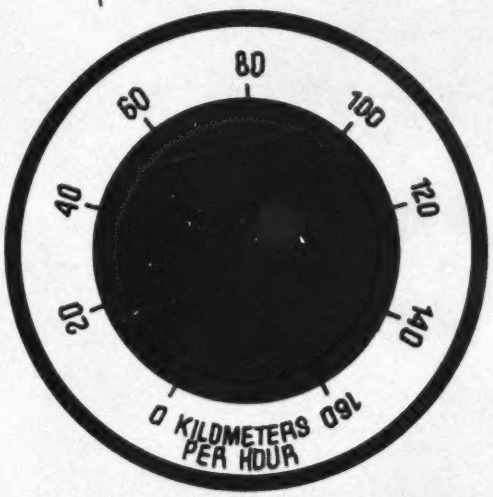


100 grams = 3.5 ounces

30 grams
= 1.1 ounces

2 LENGTH



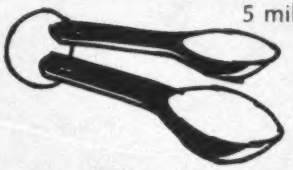


30 centimeters = 1 foot

nter...

3 VOLUME

5 milliliters = 1 teaspoon



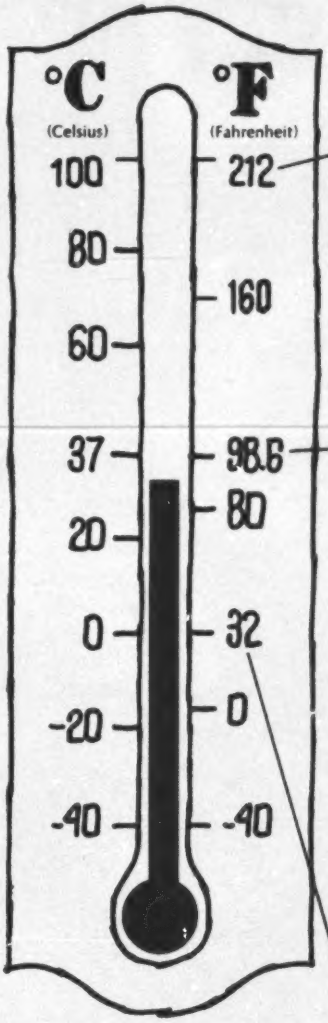
15 milliliters
= 1 tablespoon

4 liters
= 1.06 gallons

500 milliliters
= 1.06 pints

1 liter = 1.06 quarts

4 TEMPERATURE



water boils

body
temperature

water freezes

Calculations
using metric and customary units

The statement and solution of three everyday problems are given in both customary and metric units, providing a side by side comparison of the systems.

a.

Problem: What is the area of the floor of a room with the following dimensions?

	Customary Units	Metric Units
Length	15 ft 7 in	475 centimeters
Width	12 ft 6 in	380 centimeters

SOLUTION. The area is determined by multiplying the length of the room by its width. Note that for room dimensions given in mixed customary units it is necessary to first reduce them to a common unit expression which, in this case, may be either feet or inches.

CUSTOMARY—
Room Dimensions in Inches

Multiply feet by 12 to convert to inches

Length $(15 \times 12) + 7 = 187$ in
Width $(12 \times 12) + 6 = 150$ in

187×150
$= 28\,050$ square inches

Total square inches divided by number of square inches in a square foot (144) equals number of square feet

$28\,050 \div 144 = 195$ square feet (approx.)

Total square feet divided by number of square feet in a square yard (9) equals number of square yards

$195 \div 9 = 22$ square yards (approx.)

METRIC—
Room Dimensions in Centimeters

Length 475 cm
Width 380 cm

475×380
$= 180\,500$ square cm

Total square centimeters divided by number of square centimeters in a square meter (10 000) equals number of square meters; i.e. move decimal point 4 places to left

$180\,500 \div 10\,000 =$
18 square meters (approx.)

Alternate Solution
Room Dimensions in Feet

Length

$13\frac{7}{12}$ feet

Width

$12\frac{1}{2}$ feet

$15\frac{7}{12} \times 12\frac{1}{2}$ square feet

$\frac{187}{12} \times \frac{25}{2} =$

$\frac{4675}{24}$ square feet

$= 194\frac{19}{24}$ square feet

= 22 square yards (approx.)

b.

What is the approximate total weight of the contents of a basket that contains the following items:

Weight

	Customary Units	Metric Units
Meat	4 lb 9 oz	2.07 kilograms
Potatoes	3 lb 4 oz	1.47 kilograms
Tomatoes	2 lb 15 oz	1.33 kilograms
Cereal	1 lb 7 oz	650 grams

Solution of Problem

	Customary Weight in Ounces Weight in pounds multiplied by 16 gives weight in ounces	Metric Weight in Grams
Meat	(4 × 16) + 9 = 73	2070
Potatoes	(3 × 16) + 4 = 52	1470
Tomatoes	(2 × 16) + 15 = 47	1330
Cereal	(1 × 16) + 7 = 23	650
	195	5520

multiply kilograms by 1000 to convert to grams

195 divided by 16 = 12 lb (approx.) or 5.5 kilograms (approx.)

Alternate Solutions

	lb	oz	kg
Meat	4	9	2.07
Potatoes	3	4	1.47
Tomatoes	2	15	1.33
Cereal	1	7	0.65
	10	35	5.52
Or	12	3	
Or	12 lb (approx.)	or	5.5 kg (approx.)

c.

Volume

What is the volume of the following two comparable but not equal mixtures:

	Customary Units	Metric Units
Milk	1 gal 2 qt 1 pt	6.5 liters
Water	3 qt 1 pt	3.5 liters
Flavoring	½ pt	250 milliliters

Solution of Problem

	Customary Volume in Pints Multiply gallons by 8, and quarts by 2 to convert to pints	Metric Volume in Milliliters
Milk	(1 × 8) + (2 × 2) + 1 = 13	6500
Water	(3 × 2) + 1 = 7	3500
Flavoring	½	250
	20½	10250

multiply liters by 1000 to convert to milliliters

20½ ÷ 2 = 10 qt (approx.) or 10 liters (approx.)

10 ÷ 4 = 2½ gal (approx.) or 10 liters (approx.)

Alternate Solutions

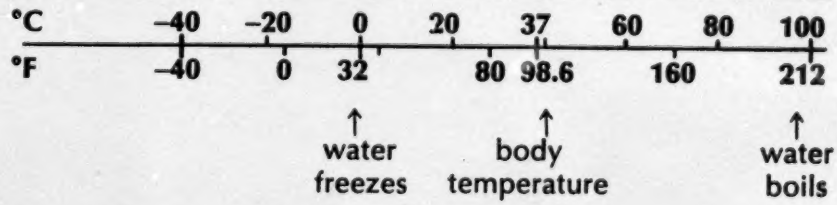
	gal	qt	pt	liters
Milk	1	2	1	6.5
Water		3	1	3.5
Flavoring			½	0.25
Totals	1	5	2½	10.25
	2	2	½	
	or 2½ gal (approx.)			or 10 liters (approx.)

Everyday units of MEASUREMENT

The few metric units of measurement that we will be using in our everyday lives and their approximate sizes are given on this page.

Measurement	Metric Unit	Approximate Size of Unit
Length	millimeter	diameter of a paper clip wire
	centimeter	a little more than the width of a paper clip (about 0.4 inch)
	meter	a little longer than a yard (about 1.1 yards)
	kilometer	somewhat further than ½ mile (about 0.6 mile)
Weight (mass)	gram	a little more than the weight of a paper clip
	kilogram	a little more than 2 pounds (about 2.2 pounds)
	metric ton	a little more than a short ton (about 2200 pounds)
Volume	milliliter	five of them make a teaspoon
	liter	a little larger than a quart (about 1.06 quarts)
Area	hectare	about 2.5 acres
Pressure	kilopascal	atmospheric pressure is about 100 kilopascals
Temperature	degree Celsius	see temperature scale below

TEMPERATURE



What Will METRIC Mean To You?

in the MARKETPLACE

As metric measures become commonplace, one of the first things you will notice as you shop will be the new metric expressions for weight, volume, and length on packaged goods.

Currently, in packaged foods, the number of different expressions of measurement you encounter in one day's shopping is bewildering. Weights are expressed in avoirdupois ounces and pounds; fluid measures are expressed in gallons, liquid quarts, pints, and fluid ounces; and dry measures are expressed in bushels, pecks, dry quarts, and pints. Only our long familiarity with the customary system has made it usable.

With metric labeling, weight will be expressed only in *grams* or kilo*grams*; volume will be expressed only in *liters* or milli*liters*; and length will be expressed only in *meters*, centi*meters* or milli*meters*. Clearly, metric is much less confusing and will be much easier to use when shopping.

in the HOME

Some of the most frequent measurements made in the home are those for cooking and baking. The practice that will be most generally followed in metric recipes should not differ from our current practice. Metric "cup and spoon" measures are only slightly larger than, and can

be used interchangeably with, the customary "cup and spoon" measures in common use in American households. It is only those few ingredients that are now measured by weight (pounds and ounces) that will be expressed differently in metric recipes. To convert a customary recipe to metric just remember that a pound is about 450 grams and an ounce is about 28 grams.

Temperatures in metric recipes are given in degrees Celsius rather than degrees Fahrenheit. If your range thermometer or thermostat is calibrated in degrees Fahrenheit, simply multiply the Celsius temperature given in your recipe by 2 to obtain, quite closely, the corresponding Fahrenheit temperature. This method of conversion is accurate within 9 °F over the range 240-400 °F.

as a WORKER

Many mechanics, machinists, and assembly plant workers will use metric tools, such as wrenches, dies, and taps, that are different in size from those now used. For a while, because of the need to maintain tools in metric and customary unit sizes, they will have a larger number of such tools from which to select. In the long run, however, use of metric units and tools should reduce the number of tools required as the number of sizes of fasteners and other components used in the manufacture of products is reduced.

Sales personnel in hardware, paint, and fabric stores will also be affected by the metric changeover. When a customer wishes to purchase lumber or paint or wallpaper, the hardware store employee may be required to calculate for the customer the amount needed to cover an area with paint or wallpaper, or how much lumber will be needed to build a deck. With the use of metric, these calculations will be less complicated. The fabric store employee may likewise be asked to calculate the amount of cloth needed to drape a window, cover a chair, or make a dress.

For most other workers, the knowledge of metric units that they will learn as consumers will enable them to carry out their duties as efficiently as in the past.

A Word from the Acting Director

I hope you have found this booklet helpful in understanding the metric system of measurement, particularly as it pertains to your everyday life. With passage of the Metric Conversion Act of 1975, we have entered a new, accelerated phase on the road to metric—a phase that makes this booklet, newly revised, even more useful.

It is now national policy to coordinate and plan for increasing use of the metric system. More and more we will see the results of this policy as our children are taught the metric system in school; as road signs on our highways begin to give distances in kilometers and speed limits in kilometers per hour; as more consumer goods are made and labeled to metric specifications; and as the news media disseminate information in metric units.

The National Bureau of Standards has been proud to serve as the Nation's principal metric resource during the period of national policy debate. Although many of the Bureau's metric information functions will be assumed by the new U.S. Metric Board, NBS will continue to serve as the authoritative source of accurate, compatible, and useful physical measurements. We will also continue to work with State and Federal agencies, universities, industry, and other groups as the focal point for assuring the integrity of measurements used throughout the United States.

ERNEST AMBLER

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